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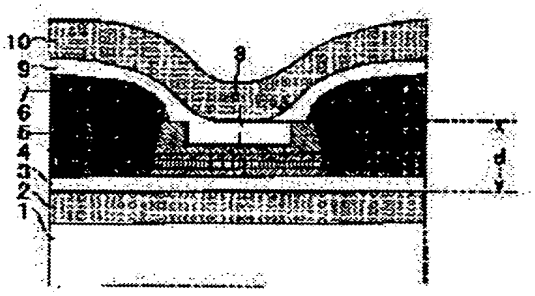
(54) MAGNETORESISTANCE EFFECT ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To make a lead gap narrower in a magnetoresistance effect element without deteriorating the characteristics of the element.
SOLUTION: The magnetoresistance effect element has a magnetoresistance effect film 4-7 patterned in an arbitrary shape including at least one antiferromagnetic substance layer 7 and magnetic shielding layers 2, 10 disposed on the upper and lower sides of the magnetoresistance effect film 4-7 by way of lead gap layers 3, 9, respectively. The antiferromagnetic substance layer 7 has a part 8 having a smaller thickness than other parts.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] the magnetoresistance-effect element which consists of a magnetoresistance-effect film by which has at least one-layer antiferromagnetic substance layer, and patterning was carried out to arbitrary configurations, and a magnetic-shielding layer prepared in the upper and lower sides of the aforementioned magnetoresistance-effect film through the lead gap layer -- setting -- the above -- the magnetoresistance-effect element characterized by preparing the closing-in section to which thickness differs from other portions in a part of one-layer antiferromagnetic substance layer even if few
[Claim 2] The magnetoresistance-effect element according to claim 1 characterized by preparing the above-mentioned closing-in section in the portion which participates in signal reading of a magnetoresistance-effect element.
[Claim 3] The magnetoresistance-effect element according to claim 2 characterized by the above-mentioned magnetoresistance-effect film having structure to which the laminating of the free layer which consists of a magnetic film of one or more layers, a non-magnetic layer, the pinned layer which consists of a magnetic film of one or more layers, and the antiferromagnetic substance layer was carried out one by one.
[Claim 4] The magnetoresistance-effect element according to claim 2 characterized by the above-mentioned magnetoresistance-effect film having structure to which the laminating of an antiferromagnetic substance layer, the pinned layer which consists of a magnetic film of one or more layers, a non-magnetic layer, the free layer which it becomes from the magnetic film of one or more layers, a non-magnetic layer, the pinned layer which consists of a magnetic film of one or more layers, and the antiferromagnetic substance layer was carried out one by one.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the magnetoresistance-effect element which has the feature in the structure for the lamination of the spin bulb film especially used for the read head of magnetic recording media, such as a hard disk drive (HDD), about a magnetoresistance-effect element.
[0002]
[Description of the Prior Art] In connection with the rise of the need of the miniaturization of a hard disk drive unit in recent years and large-capacity-izing, high-sensitivity-izing and detailed-ization are called for also from the read head element which research and development of the hard disk drive unit in which high-density magnetic recording is possible are furthered quickly, therefore constitutes a magnetic recording medium, and the magnetometric sensor which used the huge magnetic-reluctance (GMR) effect that a big output was obtained by the low magnetic field is developed in the point of high-sensitivity-izing.
[0003] For example, although "the magnetic-reluctance sensor (refer to JP,4-358310,A) of the spin bulb effect use" is proposed by IBM This magnetometric sensor is equipped with two ferromagnetic layers which was separated by the non-magnetic metal layer and which have not been combined. In the point that have a sandwich structure which adheres the antiferromagnetic substance layer represented with FeMn to one ferromagnetic layer and by which the magnetization M of a ferromagnetic layer is being fixed to it, and the high magnetoresistance effect is acquired to the minute magnetic field from a record medium it is markedly alike, a conventional inductive head or the conventional AMR (Anisotropy Magneto-Resistivity) film is excelled, and it is used as a high sensitivity read head element
[0004] In this magnetometric sensor, if shell external magnetic fields, such as a magnetic-recording medium, are impressed, since the magnetization direction of the ferromagnetic layer of another side where magnetization is not being fixed, i.e., a free (free) layer, will rotate freely in accordance with an external magnetic field, the magnetization direction and angle difference of the ferromagnetic layer to which magnetization was fixed, i.e., a PINDO (pinned) layer, will be produced.
[0005] Since dispersion for which it depended on the spin of conduction electron depending on this angle difference changes and an electric resistance value changes By detecting this electric resistance value change as a voltage value change by passing the sense current of a constant current, the signal magnetic field from the situation, i.e., the magnetic-recording medium, of an external magnetic field is acquired, and the magnetic-reluctance rate of change of this spin bulb magnetic-reluctance sensor becomes about about 5%.
[0006] "The double spin bulb magnetic-reluctance sensor (refer to JP,6-223336,A)" is proposed by IBM the same [for raising the efficiency of such a spin bulb magnetic-reluctance sensor], and this dual (double) spin bulb magnetic-reluctance sensor carried out the laminating of the spin bulb structure symmetrically the center [a free layer], and has obtained a twice [about] as many magnetic-reluctance change as this by this composition.
[0007] Since the fixed field system which turns into a vice-magnetic field to every up-and-down pinned layer can be given unlike FeMn which is the conventional irregular alloy type when the Pd-Pt-Mn alloy which is an ordered-alloy type as an antiferromagnetic substance layer of such a dual spin bulb magnetic-reluctance sensor is used especially (see Japanese Patent Application No. No. 257068 [eight to] if required), a reliable dual structure spin bulb magnetic-reluctance sensor can be formed easily. That is, conventionally, in FeMn used as an antiferromagnetic substance layer, since it became the antiferromagnetic substance only when it deposited on the film of fcc (face-centered cubic) structure, there was a problem that it could not use as an up pinned layer of a dual spin bulb magnetic-reluctance sensor.
[0008] Here, with reference to drawing 7 , a conventional spin bulb element and a conventional dual spin bulb element are explained briefly.
Drawing 7 (a) reference drawing 7 (a) is the rough important section cross section of the conventional spin bulb element. First, it is aluminum 2O3 on the aluminum2 O3-TiC substrate 41 used as the parent of a slider. The lower shield layer 43 which consists of a NiFe alloy etc. through a film 42 is formed. subsequently aluminum 2O3 etc. -- the pinned layer 47 which consists of a Cu interlayer 46 who is the free layer 45 and non-magnetic layer which consist of ferromagnetic layers, such as a laminated structure of NiFe and CoFe, CoFe, etc. after forming the lower lead gap lay r 44 -- and The spin bulb film which is made to carry out the laminating of the antiferromagnetic substance layer 48 which consists of PdPtMn etc., and serves as a magnetoresistance-effect element is formed.
[0009] subsequently, after carrying out patterning of the magnetoresistance-effect element to a predetermined configuration, the electric conduction film which consists of W or Au is deposited on the ends of a magnetoresistance-effect element -- making -- the lead electrode 49 -- carrying out -- subsequently -- again -- aluminum 2O3 etc. -- from -- the basic structure of a spin bulb element is completed by forming the up shield layer 51 which consists of a NiFe alloy etc. through the becoming up lead gap layer 50 In addition, the basic structure of a magnetoresistance-effect element is formed by heat-treating, where the 1st magnetic field and the 2nd magnetic field which intersects perpendicularly are impressed in a vacuum, after making the free layer 45 or the antiferromagnetic substance layer 48 deposit one by one, and determining the magnetization direction of the antiferromagnetic substance layer 48, where the 1st magnetic field is impressed in this case. [0010] The lead gap in this spin bulb element serves as an interval which summed up the thickness of the lower lead gap layer 43, the free lay r 45 or the antiferromagnetic substance layer 48, and the up lead gap layer 49.
[0011] Drawing 7 (b) reference drawing 7 (b) is the rough important section cross section of the conventional dual spin bulb element. First, it is aluminum 2O3 on the aluminum2 O3-TiC substrate 41 used as the parent of a slider. The lower

shield layer 43 which consists of a NiFe alloy etc. through a film 42 is formed. subsequently aluminum 2O3 etc. -- from, after forming the becoming lower lead gap layer 44 the pinned layer 47 which consists of the free layers 45, such as a laminated structure of the pinned layer 53 which consists of antiferromagnetic substance layers 52, such as PdPtMn, CoFe, etc., the Cu interlayer 54, NiFe, and CoFe, a Cu interlayer 46, CoFe, etc. -- and The dual spin bulb film which is made to carry out the laminating of the antiferromagnetic substance layer 48 which consists of PdPtMn etc., and serves as a magnetoresistance-effect element is formed.
[0012] subsequently, after carrying out patterning of the magnetoresistance-effect element to a predetermined configuration, the electric conduction film which consists of W or Au is deposited on the ends of a magnetoresistance-effect element -- making -- the lead electrode 49 -- carrying out -- subsequently -- again -- aluminum 2O3 etc. -- from -- by forming the up shield layer 51 which consists of a NiFe alloy etc. through the becoming up lead gap layer 50, the basic structure of a dual spin bulb element is completed In addition, the basic structure of a magnetoresistance-effect element is formed by heat-treating, where the 1st magnetic field and the 2nd magnetic field which intersects perpendicularly are impressed in a vacuum, after making the antiferromagnetic substance layer 52 or the antiferromagnetic substance layer 48 deposit one by one, and determining the magnetization direction of the antiferromagnetic substance layers 48 and 52, where the 1st magnetic field is impressed also in this case.
[0013] The lead gap in this dual spin bulb element serves as an interval which summed up the thickness of the lower lead gap layer 43, the antiferromagnetic substance layer 52 or the antiferromagnetic substance layer 48, and the up lead gap layer 49.
[0014] In such a spin bulb element, the magnetization direction of pinned layers 47 and 53 is fixed in the magnetization direction of the antiferromagnetic substance layers 48 and 52, respectively, on the other hand, the magnetization direction of the free layer 45 turns into a direction which intersected perpendicularly with the magnetization direction of pinned layers 47 and 53 mostly, and an external impression magnetic field, i.e., the magnetic field which leaked and came out of the magnetic-recording medium, is measured by passing sense current among one pair of lead electrodes 49.
[0015] Since the storage capacity of the magnetic-recording disk for computers in recent years is becoming very important [narrow-gap-izing of the lead gap which determines the bit length of a reading signal with the appropriate thing of the ultra-fine processing technology of the magnetoresistance-effect element width of face used as the lead width of recording track] in order to obtain sufficient signal regeneration output from the record bit which densification is progressing at an annual 1.6 time speed, and turned minutely by such densification, this situation is explained with reference to drawing 8 .
[0016] The interval d of the magnetic-shielding layer of the upper and lower sides of as opposed to the magnetic-recording medium 56 in drawing 8 reference drawing 8 That is, the magnetoresistance-effect element 55 which is explanatory drawing of the relation between a lead gap and recording density, and was pinched by the lower shield layer 43 and the up shield layer 49 is the bit length Lb recorded on the magnetic-recording medium 56 which counters. Although the record bit 57 will be read one by one the lead gap d -- bit length Lb of the record bit 57 the influence of the magnetic field of the record bit 57 adjoined other than record bit 57 for reading if it receives and becomes large too much -- receiving -- a position, since resolution falls The lead gap d is bit length Lb so that the magnetic field of the record bit 57 adjoined other than record bit 57 for reading may be absorbed by the lower shield layer 43 and the up shield layer 49. It is adjusted to d<=2Lb so that it may become below double precision.
[0017]
[Problem(s) to be Solved by the Invention] However, with progress of multimedia-izing in recent years, the further densification of a magnetic disk unit is demanded, and it follows on densification, and is the bit length Lb of the record bit 57. When it turns minutely further, it is necessary to make the lead gap d still narrower, and for that to thin-layer-ize the lower lead gap layer 43 and the up lead gap 49, or to thin-layer-ize magnetoresistance-effect element 55 the very thing.
[0018] However, when lamination of the lower lead gap layer 43 and the up lead gap 49 is carried out, the isolation voltage of a lead gap layer poses a problem, and there is a limitation in thin film-ization of a lead gap layer.
[0019] On the other hand, although thin-film-izing of the antiferromagnetic substance layers 48 and 52 with the thickest relative thickness is the most effective when carrying out lamination of the magnetoresistance-effect element 55, if thickness of the antiferromagnetic substance layers 48 and 52 is made thin, the fixed force of the magnetization direction of pinned layers 47 and 53 will become weak, and degradation of an element property, especially the fall of magnetic field detection sensitivity will pose a problem.
[0020] Therefore, this invention aims at narrow-gap-izing a lead gap, without degrading an element property.
[0021]
[Means for Solving the Problem] Drawing 1 is explanatory drawing of the theoretic composition of this invention, and explains the The means for solving a technical problem in this invention with reference to this drawing 1 . In addition, drawing 1 is the rough important section cross section of a spin bulb element.
The drawing 1 reference (1) this invention has at least one-layer antiferromagnetic substance layer 7. In the magnetoresistance-effect element which consists of magnetoresistance-effect films 4-7 by which patterning was carried out to arbitrary configurations, and magnetic-shielding layers 2 and 10 prepared in the upper and lower sides of the magnetoresistance-effect films 4-7 through the lead gap layers 3 and 9 It is characterized by forming the closing-in section 8 in which thickness differs from other portions in a part of at least one-layer antiferromagnetic substance layer 7.
[0022] Thus, thickness of the antiferromagnetic substance layer 7 can be made thin in efficiency, without reducing the fixed magnetism to a pinned layer 6 by forming the closing-in section 8 to which thickness differs from other portions in a part of at least one-layer antiferromagnetic substance layer 7.
[0023] (2) Moreover, this invention is characterized by the closing-in section 8 preparing in the portion which participates in signal reading of a magnetoresistance-effect element in the above (1).
[0024] Thus, the reading sensitivity from the magnetic-recording medium in which could narrow the lead gap d and high-density record was carried out by it can be improv d, without reducing the fixed magnetism to a pinned layer 6 by forming the closing-in section 8 in the portion which participates in signal reading of a magnetoresistance-effect element.
[0025] (3) Moreover, this invention is characterized by the magnetoresistance-effect films 4-7 having structure to which the laminating of the pinned layer 6 which consists of a magnetic film of the free layer 4 which consists of a

magnetic film of one or more layers, and 5 or 1 or more layers of non-magnetic layers, and the antiferromagnetic substance layer 7 was carried out one by one in the above (2).
[0026] The above-mentioned composition of (2) can improve the reading sensitivity of a single spin bulb element by applying to the single spin bulb element which the magnetoresistance-effect films 4-7 become from the structure to which the laminating of the pinned layer 6 which consists of a magnetic film of the free layer 4 which consists of a magnetic film of one or more layers, and 5 or 1 or more layers of non-magnetic layers, and the antiferromagnetic substance layer 7 was carried out one by one. In addition, the antiferromagnetic substance layer 7 may be formed in a substrate 1 side, or is good also as the topmost part of the magnetoresistance-effect films 4-7.
[0027] (4) Moreover, this invention is characterized by the magnetoresistance-effect film having structure to which the laminating of the pinned layer 6 which consists of a magnetic film of an antiferromagnetic substance layer, the pinned layer which consists of a magnetic film of one or more layers, a non-magnetic layer, the free layer 4 which it becomes from the magnetic film of one or more layers, and 5 or 1 or more layers of non-magnetic layers, and the antiferromagnetic substance layer 7 was carried out one by one in the above (2).
[0028] The above-mentioned composition of (2) can improve the reading sensitivity of a dual spin bulb element by applying to the dual spin bulb element which a magnetoresistance-effect film becomes from the structure to which the laminating of the pinned layer 6 which consists of a magnetic film of an antiferromagnetic substance layer, the pinned layer which consists of a magnetic film of one or more layers, a non-magnetic layer, the free layer 4 which it becomes from the magnetic film of one or more layers, and 5 or 1 or more layers of non-magnetic layers, and the antiferromagnetic substance layer 7 was carried out one by one. In addition, when what is necessary is just to form the closing-in section 8 in either [at least] the antiferromagnetic substance layer by the side of a substrate 1, or the antiferromagnetic substance layer 7 of the topmost part of a magnetoresistance-effect film and it prepares in both, the effect of the formation of a ** lead gap serves as the maximum.
[0029]
[Embodiments of the Invention] Here, with reference to drawing 2 and drawing 3 , the manufacturing process of the spin bulb element of the gestalt of operation of the 1st of this invention is explained.
Drawing 2 (a) It is aluminum 2O3 with a thickness of 2 micrometers about the sputtering method on the aluminum2 O3-TiC substrate 11 first 3 **. Impressing the magnetic field of 100Oe using selection electrolysis plating, after making a film 12 deposit Thickness forms a 3-micrometer NiFe film, and considers as the lower shield layer 13, subsequently the sputtering method is used, and thickness is 500A (=50nm) aluminum 2O3. A film is made to deposit and it considers as the lower lead gap layer 14.
[0030] Subsequently, the sputtering method is used as a spin bulb film, impressing the magnetic field of 30Oe. The thickness it is thin in a ground layer For example, after forming the 50A Ta film 15, Thickness for example, the 40A NiFe free layer 16 and thickness For example, the 25ACoFe free layer 17 and thickness act as the 25A Cu interlayer 18, and thickness acts the laminating of the 25A CoFe pinned layer 19 and the PdPtMn antiferromagnetic substance layer 20 whose thickness is 100-300A, for example, 250A, one by one. In addition, composition of NiFe in this case is nickel81Fe19, and composition of CoFe is Co90Fe10, and composition of PdPtMn is Pd31Pt17Mn52.
[0031] Subsequently, it considers as the direction of the direct-current magnetic field which impressed the magnetization direction of the PdPtMn antiferromagnetic substance layer 20 by performing heat treatment of 1 - 3 hours at 230 degrees C in a vacuum, impressing the direct-current magnetic field of 100 kA/m of the direction which intersects perpendicularly with the magnetic field impressed at the time of membrane formation, since the magnetization direction of the CoFe pinned layer 19 is fixed. In addition, the CoFe free layer 17 used as a barrier layer is formed among both, and the free layer is made into two-layer structure so that the counter diffusion between Cu(s) and the NiFe free layers 16 which constitute the Cu interlayer 18 in a 230-degree C heat treatment process in this case may not arise.
[0032] Drawing 2 (b) 3 **, subsequently, by giving ion milling using Ar ion by using the resist pattern 21 as a mask, it **********s so that it may leave only 20-100A only of 50A only of portions used as the reading field of the PdPtMn antiferromagnetic substance layer 20, for example, and thickness forms the 50A thin layer-ized section 22.
[0033] Drawing 3 (c) 3 **, subsequently, after removing the resist pattern 21, it operates orthopedically in an element configuration by carrying out selective etching of the PdPtMn antiferromagnetic substance layer 20 or the Ta film 15 by giving ion milling using Ar ion by using as a mask the resist pattern 23 formed by newly applying and carrying out patterning of the photoresist.
[0034] Drawing 3 (d) After removing the resist pattern 23, subsequently thickness by the lift-off method using the resist pattern (not shown) 3 ** for example, by depositing 1200A W film One pair of lead electrodes 24 are formed, and, subsequently thickness is 500A aluminum 2O3 by the sputtering method again. A film is made to deposit and it considers as the up lead gap layer 25. subsequently When thickness forms a 3.8-micrometer NiFe film and considers as the up shield layer 26 with selection electrolysis plating, the basic composition of a single spin bulb element is completed.
[0035] The lead gap d in this case serves as an interval between the lower shield layers 13 and the up shield layers 26 in the position in which the lamination section 22 was formed, and it follows. d= 500+50+40+25+25+25+50+500 = 1215 (A)
Compared with 1415A when not forming a next door and the lamination section 22, about about 15% of narrow gap-ization is attained.
[0036] Thus, when the lamination section 22 is formed in the reading field of the PdPtMn antiferromagnetic substance layer 20, Although the direct magnetization direction fixed force of the field corresponding to the lamination section 22 of the CoFe pinned layer 19 becomes weaker Since the magnetization direction fixed force of the center section of the CoFe pinned layer 19 is also compensated according to the magnetization direction fixed force of acting on the ends of the CoFe pinned layer 19 by which bias was carried out to reading in the ends of the PdPtMn antiferromagnetic substance layer 20 which has sufficient thickness which does not involve, a property does not deteriorate.
[0037] Next, with reference to drawing 4 and drawing 5 , the manufacturing process of the dual spin bulb element of the form of operation of the 2nd of this invention is explained.
Drawing 4 (a) It is aluminum 2O3 with a thickn ss of 2 micrometers about the sputtering method on the aluminum2 O3-TiC substrate 11 first 3 **. Impressing the magnetic field of 100Oe using selection electrolysis plating, after making a film 12 deposit Thickness impressing the magnetic field of 100Oe again using selection electrolysis plating which used the resist pattern 27 as the mask, after thickness forms a 3-micrometer NiFe film and considers as the lower shield layer 13 by for example, 200A width of face is 0.5 micrometers — it heaps up NiFe and the section 28 is formed

[0038] Drawing 4 (b) 3 **, subsequently, after removing the resist pattern 27, the sputtering method is used, and thickness is 500A aluminum 2O3. A film is made to deposit and it considers as the lower lead gap layer 14. subsequently Impressing the magnetic field of 30Oe, after forming the resist pattern 29, using the sputtering method, a 200A PdPtMn film is made to deposit and thickness forms the PdPtMn thick section 30 which heaps up NeFe and embeds the level difference by the section 28.
[0039] Drawing 4 (c) subsequently by removing the resist pattern 29 3 ** After also removing simultaneously the PdPtMn film (not shown) deposited on the resist pattern 29, The sputtering method is used again, impressing the magnetic field of 30Oe. thickness The 50A PdPtMn thin film section 31 and thickness for example, for example, the 25A CoFe pinned layer 32 and thickness The 25A Cu interlayer 33 and thickness for example, for example, the free layer 34 of a three-tiered structure which consists of a 25A CoFe film / a 20A NiFe film / 25A CoFe and thickness For example, the 25A Cu interlayer 18 and thickness carry out the laminating of the 25A CoFe pinned layer 19 and the PdPtMn antiferromagnetic substance layer 20 whose thickness is 100-300A, for example, 250A, one by one. In addition, composition of NiFe is nickel81Fe19 also in this case, and composition of CoFe is Co90Fe10, and composition of PdPtMn is Pd31Pt17Mn52.
[0040] Subsequently, it considers as the direction of the direct-current magnetic field which impressed the magnetization direction of the PdPtMn antiferromagnetic substance layer 20, the PdPtMn thick section 30, and the PdPtMn thin film section 31 by performing heat treatment of 1 - 3 hours at 230 degrees C in a vacuum, impressing the direct-current magnetic field of 100 kA/m of the direction which intersects perpendicularly with the magnetic field impressed at the time of membrane formation, since the magnetization direction of the CoFe pinned layers 19 and 32 is fixed. In addition, the CoFe film used as a barrier layer is prepared between the Cu interlayers 18 and 33 and a NiFe film, and the free layer 34 is made into the three-tiered structure so that the counter diffusion between Cu which constitutes the Cu interlayers 18 and 33 in a 230-degree C heat treatment process also in this case, and NiFe which constitutes the free layer 34 may not arise.
[0041] Subsequently 3 ** by giving ion milling using Ar ion by using a resist pattern (not shown) as a mask like the process after drawing 5 (d) drawing 2 in the form of the 1st operation of the above (b) It **********s so that it may leave only 20-100A only of 50A only of portions used as the reading field of the PdPtMn antiferromagnetic substance layer 20, for example, and thickness forms the 50A thin layer-ized section 22.
[0042] Subsequently, after removing a resist pattern, it operates orthopedically in an element configuration by carrying out selective etching of the PdPtMn antiferromagnetic substance layer 20 or the PdPtMn thick section 30 by giving ion milling using Ar ion by using as a mask the resist pattern (not shown) formed by newly applying and carrying out patterning of the photoresist.
[0043] After removing a resist pattern, thickness forms one pair of lead electrodes 24 by depositing 1200A W film by the lift-off method using the resist pattern (not shown) again. subsequently, subsequently Again, thickness is 500A aluminum 2O3 by the sputtering method. A film is made to deposit and it considers as the up lead gap layer 25. subsequently When thickness forms a 3.8-micrometer NiFe film and considers as the up shield layer 26 with selection electrolysis plating, the basic composition of a dual spin bulb element is completed.
[0044] The lead gap d in this case serves as an interval between the thin layer-ized section 22, and the lower shield layer 13 and the up shield layer 26 in the position in which it heaped up NiFe and the section 28 was formed. Therefore, it becomes d=500+50+25+25+25+20+25+25+25+50+500=1270(A), and about about 24% of narrow gap-ization is attained compared with the thin layer-ized section 22 and 1670A when heaping up NiFe and not forming the section 28.
[0045] When the thin layer-ized section 22 is formed in the reading field of the PdPtMn antiferromagnetic substance layer 20 also in this case, Although the direct magnetization direction fixed force of the field corresponding to the thin layer-ized section 22 of the CoFe pinned layer 19 becomes weaker The magnetization direction fixed force of the center section of the CoFe pinned layer 19 is also compensated according to the magnetization direction fixed force of acting on the ends of the CoFe pinned layer 19 by which bias was carried out to reading in the ends of the PdPtMn antiferromagnetic substance layer 20 which has sufficient thickness which does not involve, and the CoFe pinned layer 32 is also received. Since the magnetization direction fixed force of the center section of the CoFe pinned layer 32 is also compensated according to the magnetization direction fixed force of acting on the ends of the CoFe pinned layer 32 as for which bias was carried out to reading by the PdPtMn thick section 30 which has sufficient thickness which does not involve, a property does not deteriorate.
[0046] next, drawing 6 -- referring to -- the modification of the form of the 1st and operation of the 2nd of this invention -- explaining .
As drawing 6 (a) reference drawing 6 (a) is the modification of the form of operation of the 1st of this invention and it is shown in drawing In order to prepare the closing-in section to the spin bulb which prepared the antiferromagnetic substance layer in the substrate side and to form such structure The effect of the formation of a ** lead gap in drawing 3 (a) in the form of the 2nd operation of the above - drawing 3 (b) which heaps up, should just use the formation process of the section 28 and the PdPtMn thick section 30 as it is, and is obtained NiFe is the same as the form of the 1st operation of the above.
[0047] Although a manufacturing process is complicated rather than the gestalt of the 1st operation in the case of the modification of the gestalt of this 1st operation, since flattening of the front face can be carried out, when the inductive head which uses the up shield layer 26 as a lower magnetic pole layer is formed on the up shield layer 26 and it constitutes the compound-die magnetic head, patterning of an inductive head can be performed with a sufficient precision.
[0048] As drawing 6 (b) reference drawing 6 (b) is the modification of the form of operation of the 2nd of this invention and it is shown in drawing, as for the process after the deposition process of the CoFe pinned layer 32 after making the 250A PdPtMn antiferromagnetic substance layer 35 deposit, thickness should just make it be completely the same as that of the form of the above-mentioned operation of the 2nd on the lower lead gap layer 14 NiFe, without heaping up and forming the section 28.
[0049] Although a manufacturing process simplifies rather than the form of the 2nd operation in the case of the modification of the form of this 2nd operation, the effect of the formation of a ** lead gap serves as half [of the form of the 2nd operation].
[0050] In addition, although illustration is omitted In preparing the closing-in section only in one side of the PdPtMn antiferromagnetic substance layer which constitutes a dual spin bulb element In the case of drawing 6 (b), it is what may be prepared in the PdPtMn antiferromagnetic substance layer prepared in the substrate side on the contrary. in that case What is necessary is just to form the lead electrode 24, the up lead gap layer 25, and the up shield layer 26,

without forming the thin layer-ized section 22, after forming similarly to the process of above-mentioned drawing 4 (c).
[0051] As mentioned above, although the form of each operation of this invention has been explained, this invention is not restricted to the composition indicated in the form of each operation, and various kinds of change is possible for it. For example, in explanation of the form of each above-mentioned operation, although PdPtMn which is Mn system ordered-alloy type antiferromagnetism material as an antiferromagnetic substance layer is used IrMn which does not need to be Mn system ordered-alloy type antiferromagnetism material, for example, is Mn system irregular alloy type antiferromagnetism material may not necessarily be used, and it is necessary to take the crystal structure of a ground layer into consideration so that IrMn deposited in that case may have an antiferromagnetism property.
[0052] Moreover, what is necessary is not to be restricted to such a composition ratio and just to choose a composition ratio suitably as NiFe, CoFe, and PdPtMn, in the form of each above-mentioned operation, according to magnetic properties, a working characteristic, etc. to need, respectively, although nickel81Fe19, Co90Fe10, and Pd31Pt17Mn52 are used.
[0053] Moreover, in explanation of the form of each operation of the above-mentioned this invention, although the aluminum2 O3-TiC substrate is used as a substrate It is SiO2 to a front face. You may use the ferromagnetic and the antiferromagnetic substance which may use substrates, such as Si substrate in which the film was formed, or a glass substrate, and are used for usual [except having indicated in the form of operation also as a ferromagnetic and the antiferromagnetic substance and].
[0054] Moreover, in explanation of the form of the 2nd operation of the above, NiFe, although selection electrolysis plating is used in case it heaps up and the section 28 is formed, it is not restricted to selection electrolysis plating and the convex structure may be formed by **********ing the circumference by the ion milling using Ar ion, using a resist pattern as a mask for the lower shield layer made to deposit more thickly.
[0055] Moreover, in explanation of the form of the 2nd operation of the above, although the PdPtMn thick section 30 is formed by the lift-off method Not the thing restricted to the lift-off method but a PdPtMn film is thickly formed so that a front face may become abbreviation flatness. You may form by performing etchback or CMP (Chemical Mechanical Polishing) processing. further Etchback or a CMP process is stopped on the way, and you may make it the PdPtMn thin film section whose thickness is about 50A remain.
[0056]
[Effect of the Invention] the position of the MR head [it] can narrow an efficiency lead gap, without deteriorating magnetic properties, since thickness of the portion corresponding to the reading field of the antiferromagnetic substance layer which constitutes a spin bulb film is made thin compared with other portions according to this invention, and using the magnetoresistance-effect element -- the place which can improve resolution, as a result contributes to the spread of the HDD equipment of high recording density is large

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[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is explanatory drawing of the theoretic composition of this invention.
[Drawing 2] It is explanatory drawing of the manufacturing process to the middle of the spin bulb element of the gestalt of operation of the 1st of this invention.
[Drawing 3] It is explanatory drawing of the manufacturing process after drawing 2 of the spin bulb element of the gestalt of operation of the 1st of this invention.
[Drawing 4] It is explanatory drawing of the manufacturing process to the middle of the dual spin bulb element of the gestalt of operation of the 2nd of this invention.
[Drawing 5] It is explanatory drawing of the manufacturing process after drawing 4 of the dual spin bulb element of the gestalt of operation of the 2nd of this invention.
[Drawing 6] It is explanatory drawing of the modification of the gestalt of the 1st and operation of the 2nd of this invention.
[Drawing 7] It is explanatory drawing of the conventional spin bulb element.
[Drawing 8] It is explanatory drawing of the relation between a lead gap and recording density.
[Description of Notations]
1 Substrate
2 Magnetic-Shielding Layer
3 Lead Gap Layer
4 Free Layer
5 Non-magnetic Layer
6 Pinned Layer
7 Antiferromagnetic Substance Layer
8 Closing-in Section
9 Lead Gap Layer
10 Magnetic-Shielding Layer
11 Aluminum2 O3-TiC Substrate
12 Aluminum 2O3 Film
13 Lower Shield Layer
14 Lower Lead Gap Layer
15 Ta Film
16 NiFe Free Layer
17 CoFe Free Layer
18 Cu Interlayer
19 CoFe Pinned Layer
20 PdPtMn Antiferromagnetic Substance Layer
21 Resist Pattern
22 Lamination Section
23 Resist Pattern
24 Lead Electrode
25 Up Lead Gap Layer
26 Up Shield Layer
27 Resist Pattern
28 Heap Up NiFe and it is Section.
29 Resist Pattern
30 PdPtMn Thick Section
31 PdPtMn Thin Film Section
32 CoFe Pinned Layer
33 Cu Interlayer
34 Free Layer
35 PdPtMn Antiferromagnetic Substance Layer
41 Aluminum2 O3-TiC Substrate
42 Aluminum 2O3 Film
43 Lower Shield Layer
44 Lower Lead Gap Layer
45 Free Layer
46 Cu Interlayer
47 Pinned Layer
48 Antiferromagnetic Substance Layer
49 Lead Electrode
50 Up Lead Gap Layer
51 Up Shield Layer
52 Antiferromagnetic Substance Layer
53 Pinned Layer

54 Cu Interlayer
55 Magnetoresistance-Effect Element
56 Magnetic-Recording Medium
57 Record Bit

[Translation done.]